

# AN IMPROVED APPARATUS FOR THE DETERMINATION OF CARBON DIOXIDE PRODUCTION IN PHYSIOLOGICAL PLANT STUDIES

F. LYLE WYND

*Henry Shaw School of Botany of Washington University*

The method of determining carbon dioxide production described previously<sup>1</sup> has been used in this laboratory for various types of experiments over a period of two years, particularly in determining the respiration of plants in water culture. At first sight the construction of the apparatus seems complicated, but once assembled it is extremely simple. The manipulation consists of adjusting the stopcocks M and W and detaching and weighing the Fleming-Martin bulb. Five units attached to a single water-pump suction line have been successfully operated. One charging of the various chambers with the necessary chemicals is sufficient for months of use.

Experience with the apparatus has suggested the advisability of several modifications of the original construction. The calcium chloride Tower B has been added to prevent the atmospheric moisture from wetting the Ascarite in C. Stopcock A, through which the air enters, is closed when the apparatus is not in use. C is a large test-tube, 32 × 300 mm., and its inlet should terminate near the stopper and the outlet should be from the bottom, in order that the air may be drawn down through the entire mass of Ascarite and thus prevent channelling.

Two calcium-chloride towers, H and I, have replaced the former tube of concentrated sulphuric acid for the first stage of the dehydration of the air passing through the bell jar serving as the respiration chamber. This prevents the negative pressure of about one pound per square inch which existed in the carbon-dioxide absorbing part of the system when sul-

<sup>1</sup> Wynd, F. Lyle. An apparatus for the determination of carbon dioxide production in physiological plant studies. *Ann. Mo. Bot. Gard.* 19: 499-501. 1932.

phuric acid was used. Even this small negative pressure greatly increases the likelihood of leaks and limits the number of units which may be attached to the common suction line V. It has been found also that volatile substances from plants are oxidized when drawn through concentrated sulphuric acid, and that the resulting carbon dioxide and sulphur dioxide sometimes produce large errors.

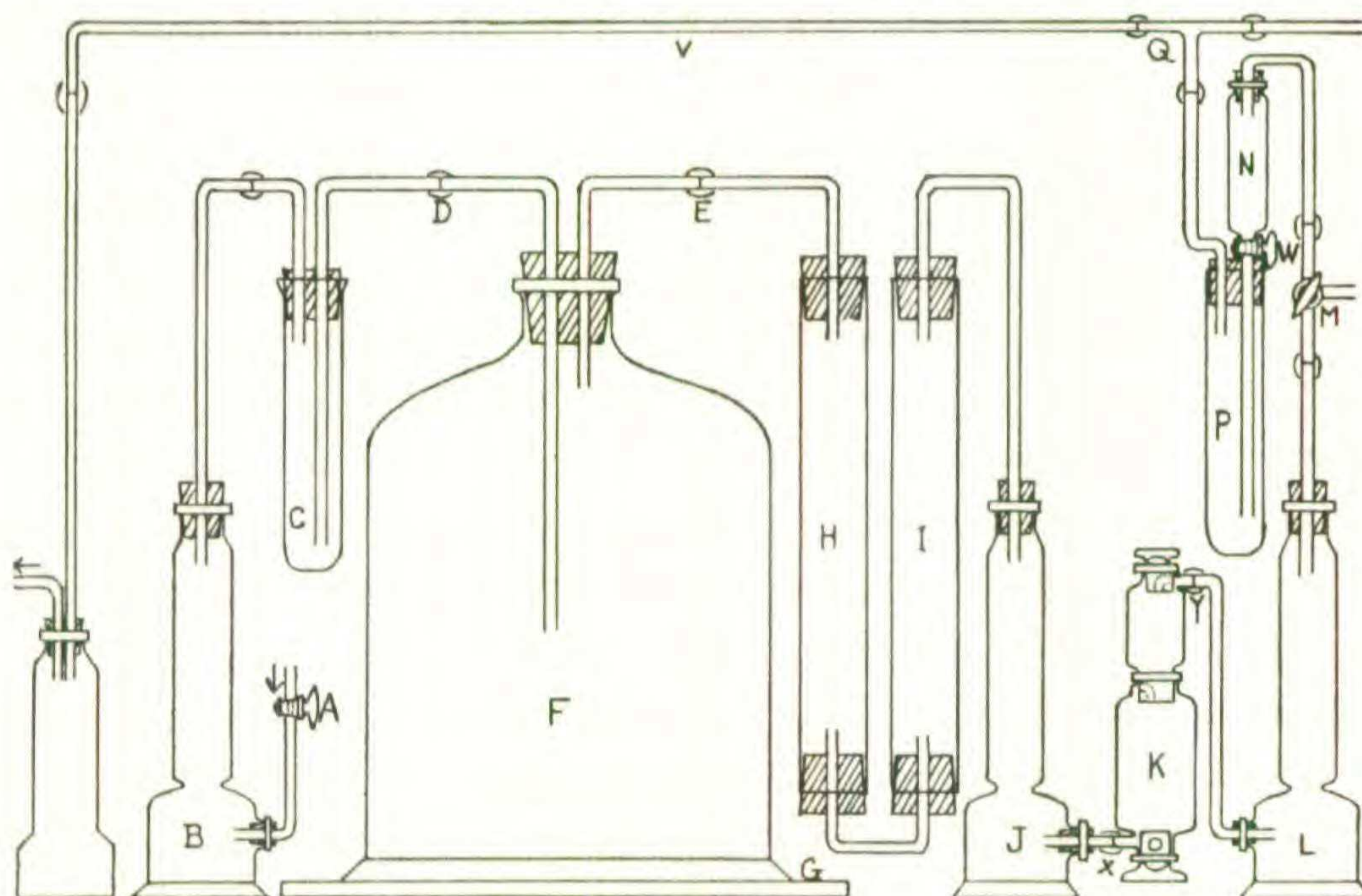


Fig. 1. Explanation in text.

The final stage of drying the air from the respiration chamber is accomplished by the tower J, which is filled with Desicchlora. This drying agent absorbs ammonia as well as water and therefore eliminates the use of a separate structure to remove this omnipresent contamination of laboratory air. The use of phosphorus pentoxide at this stage is very unsatisfactory because of its tendency to channel. The carbon-dioxide absorption bulb is the Fleming-Martin type which has been found very satisfactory for this purpose. The upper chamber is filled with Desicchlora, the lower with Ascarite. Tower L is filled with Desicchlora. M is a three-way stopcock. P is half filled with water and serves as an indicator for the regulation of the flow of air through the apparatus.

In the operation of the unit, cock W is closed and chamber N is connected to tower L through the three-way stopcock, M. After the suction has been turned on, cock W is slowly opened until the desired rate of flow is obtained. In stopping the experiment the three-way stopcock M must be turned so that air enters through its side arm, then the cock W is closed and the suction stopped. After the suction stops, W may be opened and water will not back up in the system and ruin the drying agent in L. Cock M closes off the tower L from the air and from N when the apparatus is not in use.

The apparatus may be operated for periods of twelve hours and even longer, and amounts of carbon dioxide up to several grams may be determined with an experimental error of less than one milligram if the usual analytical precautions are taken. All joints should be sealed with shellac. The detachable rubber connections at D and E should be sealed with grease. The rubber connections of the Fleming-Martin bulb should be carefully wired with copper wire. The contact of the respiration chamber with the glass plate G should be sealed by vaseline. The absorption bulb must be handled with cheesecloth, and a counterpoise, preferably another Fleming-Martin bulb, should be used in weighing. The tower J must be completely filled with the drying agent and the short glass-tube outlet should be loosely filled with cotton. If these precautions are not taken, sufficient carbon dioxide, moisture, or ammonia may accumulate in the lower part of J, when the Fleming-Martin bulb is detached for weighing, to cause an appreciable error in the next determination.

Since calcium chloride always contains some calcium oxide, the towers containing this substance must be saturated with carbon dioxide before the apparatus is used for the first time. Further details are contained in the author's original paper.